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(*b*. Florence, Italy, 5 April 1622; *d*. Florence, 22 September 1703), *mathematics*.

Viviani was the son of Jacopo di Michelangelo Viviani, a member of the noble Franchi family, and Maria Alamanno del Nente. He studied the humanities with the Jesuits and mathematics with Settimi, a friend of Galileo's. His intelligence and ability led to his presentation in 1638 to Ferdinand II de' Medici, grand duke of Tuscany. Ferdinand introduced him to Galileo, who was so impressed by his talent that he took him into his house at Arcetri as a collaborator in 1639. After Galileo's death, Viviani wrote a historical account of his life and hoped to publish a complete edition of his works. The plan, however, could not be carried out because of opposition by the Church-a serious blow not only to Viviani's reputation but even more to the progress of science in Italy. Since he was unable to purse the evolution of mathematical ideas that were developing during that period, Viviani turned his talent and inventiveness solely to the study and imitation of the ancients.

Although the Medici court gave him much work, Viviani studied the geometry of the ancients. His accomplishments brought him membership in the Accademia del Cimento, and in 1696 he became a member of the Royal Society of London. In 1699 he was elected one of the eight foreign members of the Académie des Sciences in Paris. He declined offers of high scientific positions from King John II Casimir of Poland and from Louis XIV.

Viviani's first project was an attempted restoration of a work by Aristaeus the Elder, *De locis solidis secunda divinatio geometrica*, which Viviani undertook when he was twenty-four. Aristaeus' work is believed to have been the first methodical exposition of the curves discovered by Menaechmus; but since it has been entirely lost, it is difficult to estimate how close Viviani came to the original work.

Viviani also undertook to reconstruct the fifth book of Apollonius' *Conics*, the first four books of which had been discovered and published. While examining the oriental codices in the grand duke's library in Florence, Borelli discovered a set of papers on which was written "Eight Books of Apollonius' *Conics*." (Actually, the manuscript contained only the first seven books.) Since the manuscript was in Arabic, Borelli obtained the grand duke's permission to take it to Rome, where he turned it over to Abraham Ecchellensis, who was competent to translate it into Latin. The contents of the work were kept secret however, in order to give Viviani time to complete the publication of his *De maximis et minimis*, which finally appeared at Florence in 1659. Two years later the translation of Apollonius' work was published under Borelli's editorship, and it then became possible to ascertain the substantial similarity between the two works.

Another important work was *Quinto libro degli Elementi di Euclide* (1674). With the rigor and prolixity of the ancients, Viviani devoted an appendix to geometric problems, among which was one on the trisection of an angle, solved by the use of the cylindrical spiral or of a cycloid; another was the problem of duplicating the cube, solved by means of conics or of the cubic $xy^2 = k$.

Viviani also produced the Italian version of Euclid's *Elements* (1690) that was reprinted in 1867 by Betti and Brioschi, in order to raise the level of the teaching of geometry in Italy. Following the example of other learned men of the period, Viviani proposed a problem-known as the "Florentine enigma" -that received wide recognition as soon as the foremost mathematicians began to work on it.[1] The problem was to perforate a hemispheric arch, having four equal windows, in such a way that the residual surface could be squared. Viviani solved the problem by a method that became well known.[2] It is accomplished by the intersection of four right cylinders, the bases of which are tangent to the base of the hemisphere.

There is an Italian translation by Viviani of a work by Archimedes on the rectification of a circumference and the squaring of a circle. He also collected and arranged works by Torricelli after the latter's death.[3]

The search for a point in the plane of a triangle such that the sum of the distances from the vertices shall be the minimum was proposed by Fermat to Torricelli, and by Torricelli to Viviani, who solved the problem (appendix to *De maximis et minimis*, p. 144). This problem was also solved by Torricelli and Cavalieri for triangles with angles less than 120°.[4] It led to a correspondence among Torricelli, Fermat, and Roberval to which Viviani refers (*ibid*., p. 147).

# NOTES

1. During a visit to Italy in 1689, Leibniz met Viviani and solved his problem. It was the first example of the calculation of the area of a curved surface by means of integral calculus (*Acta eruditorum* [1692], 275-279). Jakob I Bernoulli solved the problem (*ibid*.), and that work led to his study of the area of quadrics of revolution (*Acta eruditorum* [Oct. 1696]).

2. Guido Grandi demonstrated the correctness of Viviani's solution by applying the method of indivisibles. There is a reference to this solution in a letter written by Huygens to L'Hospital (*Oeuvres de C. Huygens*, X [The Hague, 1905], 829). In an appendix to this work the publishers inserted a previously unpublished passage by Huygens, in which he demonstrates that the solutions proposed by Leibniz and Viviani are identical.

3. See *Opere di Evangelista Torricelli*, **I** (Faenza, 1919), pt. 1, 329–407, and pt. 2, 3–43, 49–55.

4. B. Cavalieri, *Exercitationes geometricae sex* (Bologna, 1647), 504–510.

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I. Original Works. Viviani's writings are *De maximis et minimis geometrica divinatio in quintum Conicorum Apollonii Pergaei, adhuc desideratum* (Florence,1659); *Quinto libro di Euclide, ovvero scienza universale delle proporzioni, spiegate colla dottrina del Galileo* (Florence, 1674); *Diporto geometrico* (Florence, 1676); *Enodatio problematum universis geometricis praepositorum a D. Claudio Comiers* (Florence, 1677); *Discorso intorno al difendersi dai riempimenti e dalla corrosione dei fiumi* (Florence, 1688); *Elementi piani e solidi di Euclide agl'illustrissimi Sig. dell' Accademia de' Nobili* (Florence, 1690); *Formazione e misura di tutti i cieli* (Florence, 1692); and *De locis solidis secunda divinatio geometrica in quinque libros iniura temporum amissos. Aristaei senioris geometrae* (Florence, 1702).

II. Secondary Literature. See L. Conte, "Vincenzo Viviani e l'invenzione di due medie proporzionali," in *Periodico di matematiche*, **25** no. **4** (1952), 185; A. Fabroni, *Vitae italorum doctrina excellentium*, **I** (Pisa, 1777), 307–344; and Gino Loria, *Curve piane speciali algebriche e trascendenti*, **I** (Milan, 1930), 373; *Curve sghembe speciali algebriche e trascedenti*, **I** (Bologna, 1925), 201–233, and **II** , 63–65; and *Storia delle matematiche*, 2nd ed. (Milan, 1950), see index.

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